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An optomechanical approach to controlling the temperature and chemical potential for light[1] CHIAO-HSUAN WANG, JQI, QuICS, and University of Maryland, JACOB TAYLOR, JQI, QuICS, University of Maryland, and National Institute of Standards and Technology — Massless bosons, including photons, do not have strict particle conservation and thus have no chemical potential. However, in driven systems, near equilibrium dynamics can lead to equilibration of photons with a finite number, describable using an effective chemical potential. Here we build upon this general concept with an implementation appropriate for a nonlinear photonic or microwave quantum simulator. We consider how laser cooling of a mechanical mode can provide an effective low frequency bath for other photon modes. The parametric optomechanical interaction between the optical system and the low frequency bath is provided through a beam-splitter coupling between the optical system and another laser-driven mode. The use of multiple photon modes enables control of both the chemical potential, by drive frequency, and temperature, by drive amplitude, of the resulting photonic grand canonical ensemble.

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